A NEW MULTISCALE COMPUTATIONAL APPROACH FOR MEDIUM-FREQUENCY VIBRATIONS ON A LARGE FREQUENCY RANGE

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Today, all major numerical modeling techniques for the analysis of medium-frequency vibrations are based on finite element or boundary element approaches. In order to account for small-wavelength phenomena in complex structures (such as car chassis, satellites or ships), these techniques require huge numbers of degrees of freedom. In order to represent oscillating solutions, more than seven elements per wavelength are necessary [4]. Furthermore, the solution obtained is highly sensitive to the material properties and boundary conditions. Different approaches have been investigated in order to solve these problems, e.g. enhanced finite elements [2] or specific reduced bases [7], but most of these techniques require specific geometries or large numbers of degrees of freedom in order to yield predictive results. The use of high-frequency approaches, such as Statistical Energy Analysis (SEA) [6] or any of its improvements (see, for example, [1, 3]) does not appear suitable for medium-frequency vibrations: the vibrational behavior becomes too smooth and, in general, the coupling loss factor cannot be calculated in a predictive way.

In this paper, we present an enhancement of the Variational Theory of Complex Rays [5] which enables the complete response to be calculated on a large frequency range. It is clear that the linear system to be solved is highly dependent on the frequency being studied and on the structural parameters. Our new multiscale technique involves an original decomposition of the coefficients of the linear system into a set of "slowly-varying" coefficients and coefficients which are highly dependent on the frequency and other parameters. Then, an iterative *ad hoc* strategy for the calculation of the slow and fast parts of the solution in terms of frequency is introduced. The validity of this method is studied: numerical examples show that the oscillating behavior of the system is described well by the "fast" part of the decomposition. Then, the capabilities of the new approach are presented through applications in the case of 3D assemblies: effective quantities (such as spatial average) are compared with an "exact" solution for several frequency ranges taking into account different types of behavior (smoothed response, highly dynamic response, etc.).

References

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